

**PCT**WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G11C 11/14, 11/18	A1	(11) International Publication Number: WO 95/10112 (43) International Publication Date: 13 April 1995 (13.04.95)
<p>(21) International Application Number: PCT/US94/10914</p> <p>(22) International Filing Date: 30 September 1994 (30.09.94)</p> <p>(30) Priority Data: 08/130,479 1 October 1993 (01.10.93) US</p> <p>(71) Applicant: THE GOVERNMENT OF THE UNITED STATES OF AMERICA, represented by THE SECRETARY OF THE NAVY [US/US]; Naval Research Laboratory, Washington, DC 20375-5325 (US).</p> <p>(72) Inventor: PRINZ, Gary, A.; 1789 Duffield Lane, Alexandria, VA 22307 (US).</p> <p>(74) Agent: McDONNELL, Thomas, B.; Associate Counsel (Patents), Code 3008.2, Naval Research Laboratory, Washington, DC 20375-5325 (US).</p>	<p>(81) Designated States: CA, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report.</i></p>	

(54) Title: **ULTRA HIGH DENSITY, NON-VOLATILE FERROMAGNETIC RANDOM ACCESS MEMORY**

(57) Abstract

A random access memory element (100) utilizes giant magnetoresistance. The element (100) includes at least one pair of ferromagnetic layers (106, 110) sandwiching a nonmagnetic conductive layer (108). At least one of the two ferromagnetic layers has a magnetic moment oriented within its own plane. The magnetic moment of at least the first ferromagnetic layer of the pair has its magnetic moment oriented within its own plane and is typically fixed in direction during use. The second ferromagnetic layer of the pair has a magnetic moment which has at least two preferred directions of orientation which may or may not reside within the plane of the second ferromagnetic layer. The bit of the memory element may be set by applying to the element a magnetic field which orients the magnetic moment of the second ferromagnetic layer in one or the other of these preferred orientations. The set value is determined by the relative alignment of the magnetic moments of the first and second ferromagnetic layers.

